

# The standard of spirometry in the RSA

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## Summary

Standards for high-quality lung function testing have not yet been formally adopted in the RSA, despite the increase in the performance of spirometry. A study was undertaken to determine the standard of spirometry in clinical practice in this country. Forty-five spirometer users agreed to participate. Responses to a questionnaire, administered by personal interview, were graded according to the proportion of correct or appropriate answers: completely unsatisfactory < 33,3%; poor 33,3 - 66,6%; and satisfactory > 66,6%.

Only 6 spirometers were regularly calibrated. Knowledge of international standards for spirometry, the basic working mechanism of the spirometer being used and calibration ranged from poor to completely unsatisfactory in most of the practices. Instructions to the patient for performing the manoeuvres were satisfactory, but evaluation of the result for acceptability, reproducibility, selection of the best test and diagnosis of a positive bronchodilator response were generally completely unsatisfactory. Only 18 practitioners knew the source of the reference values they used and 5 had proved their validity with a sample. Fourteen of the 45 practitioners were unable to make the correct diagnoses from two typical test results. Of the 45 practitioners, 40 were interested in a course in practical, clinical spirometry.

In the light of the predominantly unsatisfactory results obtained in this study, we consider clinical spirometry to be an urgent priority for all levels of medical education.

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Spirometry is a quick, apparently simple, test of functional impairment of the lungs that is readily available to the clinician. Clinical estimation of the severity of pulmonary dysfunction is notoriously unreliable; in this regard it has been suggested recently that the examination of a patient with dyspnoea or lung disease is incomplete if spirometry has not been performed.<sup>1</sup> Spirometry should be performed in most patients with known or suspected disease in order to detect and to quantify functional abnormalities of the lungs and the response to therapy or a provocative stimulus.

Although international standards for spirometry have been set by the American Thoracic Society (ATS)<sup>2,3</sup> and in Europe,<sup>4</sup> there has been no attempt in the RSA formally to endorse existing or to establish local standards. Recent publications<sup>1,5,6</sup> directed at the physician in clinical practice have stressed the importance of conducting spirometry scientifically, but accurate information on the standard of spirometry conducted by clinicians, whether in North America, Europe or South Africa, is sparse. There is a suspicion, however, that these standards may not be adequate.<sup>3,7,8</sup>

Since spirometry is so important in the functional evaluation of the respiratory system and since there is no recognised formal training in the performance of the tests, we set out to determine to what extent spirometry conducted by South African clinicians meets the most important of the internationally accepted standards. We also wanted to identify specific problems and to recommend methods for improving the quality of lung-function testing in the country.

## Subjects and methods

Forty-five spirometer users in clinical practice in the Cape Peninsula and the Pretoria-Johannesburg area were included in this study. The target group was identified primarily through the suppliers of spirometers; in Johannesburg the telephone directory was also used to identify physicians and general practitioners who performed spirometry in their practices. A 30-minute appointment was made with the doctors, all of whom were assured that anonymity would be maintained. During the appointment a questionnaire was completed, volume calibration of the spirometer was checked and the usual operator performed spirometry on one of the authors (E.B.). Only one interviewer administered the questionnaire and mainly closed-ended questions were asked in a fixed format.

The questionnaire was directed to evaluate: (i) basic knowledge of the working mechanism of the apparatus; (ii) the instructions given to the patient to perform the forced vital capacity (FVC) manoeuvre and the minimum number of times the patient was required to perform the test; (iii) the doctor's ability to identify acceptable and reproducible results; (iv) the practitioner's knowledge and application of reference values; and (v) the ability to interpret typical spirometric data.

The criteria used to assess the practitioners' responses were the most important standards set by the ATS,<sup>2,3</sup> which have been emphasised in both local medical<sup>6</sup> and continuing medical education<sup>1</sup> journals.

## Results

Twelve of the 57 doctors initially contacted refused to take part in the study — in 10 practices they were 'too busy', while 2 doctors objected to the nature of the study. Thus 45 spirometer users — 25 in the Cape Peninsula and 20 in the Pretoria-Johannesburg area — consented to participate in the study and were subsequently interviewed. The group included 26 physicians, 2 thoracic surgeons, 4 paediatricians, 1 anaesthetist and 12 general practitioners.

In 28 practices, spirometry was performed by the doctor himself, but only 7 had received specific training or had attended courses in spirometry at teaching hospitals. Thirteen practices used nursing sisters and 1 used a radiographer to perform the tests, but again none of these personnel had been trained to perform spirometry. In the remaining 3 practices, spirometry was performed by clinical technologists registered in pulmonology with the South African Medical and Dental Council (SAMDC).

The frequency of performing spirometry varied between 1 test and 150 tests per week, with a median frequency of 15.

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Twenty-seven users, of whom 18 practised in the Cape Peninsula, did not have even the simplest knowledge of how their spirometer worked. Twenty-eight of the spirometer users were aware of international equipment standards and agents had provided them with satisfactory proof that their apparatus met these minimum requirements. When tested with a calibration syringe, 25 spirometers did not meet ATS standards for accurate volume calibration (viz. the measured volume must be accurate to within 3% or 50 ml, whichever is greater). In fact, only 9 doctors possessed calibration syringes and only 6 of them calibrated their spirometers regularly (daily).

With regard to a biological calibration check, one of the authors (E.B.) has an FVC which varies from day to day between 3,75 l and 3,85 l on a calibrated spirometer that meets ATS standards. When tested in the study practices, the mean FVC of the author was 3,76 l but varied between 2,89 l and 4,26 l; in 25 of the 45 practices (55%) the measured FVC was outside the usual range (Fig. 1).

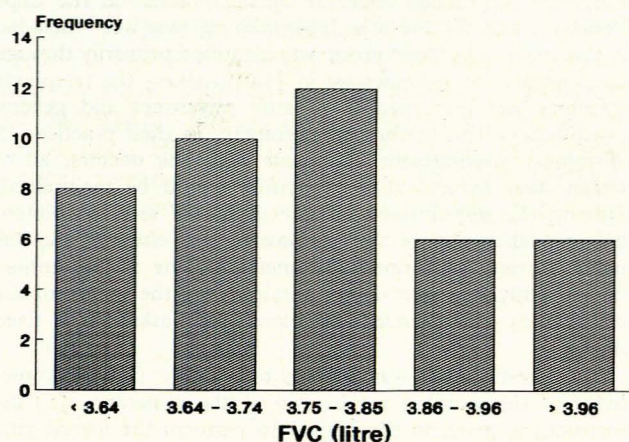


Fig. 1. Frequency distribution of FVC measurements among spirometer users for author E. B., whose FVC varies between 3,75 l and 3,85 l on a calibrated spirometer that meets ATS specifications.

Nineteen practitioners either did not know of, or did not apply, the appropriate internationally accepted body temperature, prevailing atmospheric pressure and water vapour saturation (BTPS) corrections to their spirometric data. Seventeen of the doctors did not conduct at least 3 FVC manoeuvres on their patients in order to achieve a reproducible result.

Responses to the questionnaire were graded according to the proportion of correct or appropriate answers as follows: completely unsatisfactory — less than one-third; poor — one-third — two-thirds; and satisfactory — more than two-thirds.

The FVC manoeuvre was satisfactorily monitored and controlled by 41 users, yet 43 could not describe criteria for an acceptable test result (i.e. evidence of a maximal effort and a result free of artefacts) and 37 could not give criteria for a reproducible result (e.g. both forced expiratory volume in 1 second (FEV<sub>1</sub>) and FVC reproducible to within 5%). Forty-two users were unable to explain the 'back extrapolation' method, as proposed by the ATS,<sup>2</sup> for determining the start of timed tests (e.g. FEV<sub>1</sub>). Only 6 doctors had knowledge of criteria for determining the end of the test.

Of the 42 practitioners who regularly tested for a bronchodilator response, 13 did not allow sufficient time (at least 10 minutes) for the patient to respond to the inhaled bronchodilator and 24 did not apply acceptable criteria for a positive bronchodilator response, e.g. an increase of at least 10% above the baseline in FEV<sub>1</sub> or FVC.<sup>7,9</sup>

All practitioners were required to interpret two typical test results of FEV<sub>1</sub> and FVC (one example of a lung restrictive defect and one of intrathoracic expiratory airflow obstruction). Fourteen of the 45 users were unable to make the correct diagnosis in one or both of the test examples.

Reference values were used by all the doctors and 33 considered the reference values to be applicable to the majority of their patients. However, 18 doctors in the Cape Peninsula and 9 in the Transvaal did not know the source of these values, i.e. the reference population from which the predicted 'normal' values were derived. Only 5 doctors had tested the validity of these values against results obtained from a representative sample of healthy subjects drawn from the population they served.

When identifying abnormal test results, 30 doctors selected measurements that were < 80% of the 'predicted' value, 4 selected results lower than the predicted —1,65 standard error of the estimate, while 11 doctors used the 'machine's' criteria, the nature of which they had no knowledge of. Thus, 41 practitioners used inappropriate methods or were unaware of appropriate methods for identifying test results that were likely to be abnormal at the 95% confidence interval.

## Discussion

The findings of this survey indicate that the standard of spirometry in clinical practice in South Africa is unacceptably low, despite recent local publications which have emphasised quality control.<sup>1,5,6</sup> Furthermore, only a small minority of practitioners had any appropriate training in the performance of spirometry in lung-function laboratories and, in many practices, the spirometry is performed by 'paramedical' personnel who also had no such training in spirometry. This was the first study done to determine the standard of spirometry in clinical practice in this country and the scanty evidence from North America<sup>3,7,8</sup> suggests that the situation there may also be unsatisfactory.

We had considerable difficulty in identifying spirometer users in clinical practice, since suppliers' records were generally poor. A better method of identification might have been to send questionnaires to all practitioners registered with the SAMDC, but responses to such questionnaires generally have a low yield and we are of the opinion that the trend of our results would not have been very different.

Our results were generally similar in both the geographical areas studied and we doubt whether the selection of additional locations would have influenced our conclusions. There were a few minor differences between the Transvaal and the Cape Peninsula groups: doctors in the Transvaal used a much wider range of spirometers, they were better informed on the basic working mechanism of their spirometers and they also had a better knowledge of the source of their reference values. On the other hand, results relating directly to the standard of spirometry performed were equally poor in both the areas.

The reasons for the generally poor standard of spirometry can almost certainly be related to the lack of adequate training of practitioners and other paramedical personnel conducting the tests. These findings have important implications for medical education and immediate action is required at under- and postgraduate levels, as well as in continuing medical education. It is especially disturbing that the standard of clinical spirometry remains unacceptably low despite the recent publications in South African scientific and continuing medical education journals. However, it is encouraging that 40 of the 45 practitioners expressed interest in attending a course in practical spirometry, the educational objectives of which are listed in the appendix.



Medical practitioners and students may have been taught the necessity of spirometry but they have not been adequately trained to make such measurements. Unfortunately, clinical technologists trained in pulmonology are relatively scarce and this has resulted in passing on lung-function testing to other paramedical personnel. Doctors also have a problem in selecting acceptable spirometers due to the absence of technical guidelines in the RSA. Pulmonology, on the other hand, is not a registrable sub-specialty and the South African Pulmonology Society has failed so far to provide a strong lead in endorsing and implementing international standards for high-quality lung-function testing. All of the above could definitely contribute to the bad state of affairs and a definite effort must be made to rectify the situation.

Inadequately trained personnel performing spirometry may obtain misleading results, which will have definite disadvantages. Wrong diagnosis may lead to unnecessary treatment, patient anxiety and expense. It could also lead to inappropriate settlement of claims for compensation due to respiratory disability. Action is also necessary because patients are charged for lung-function tests when they are performed.

We conclude that the standard of clinical spirometry in South Africa is unsatisfactory and that proper training is an urgent necessity at all levels of medical education. This may be achieved in co-operation with pulmonary function laboratories recognised by the SAMDC for training in pulmonology of both clinical technologists and medical personnel.

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## Appendix

### Objectives of a course in clinical spirometry

At the end of a course in clinical spirometry the practitioner should be able to:

1. List indications for doing spirometry.
2. Assess technical specifications of spirometry equipment.
3. Select an appropriate spirometer and know its basic working mechanism.
4. Calibrate a spirometer accurately with a 3-litre calibration syringe and make the appropriate BTPS adjustments to data.
5. Give the correct instructions to patients for the performance of the forced inspiratory and expiratory vital capacity tests.
6. Evaluate the acceptability and reproducibility of results.
7. Determine the start and end of a test.
8. Select the best curve and data.
9. Select appropriate reference values and understand their limitations.
10. Make a correct diagnosis of a restrictive defect and of the different forms of airflow obstruction.
11. Perform a bronchodilator test, express the results appropriately and identify a significant response.

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